

# PATENT ABSTRACTS OF JAPAN

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## (54) PRODUCTION OF OPTICAL MEMBER

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To produce an optical member excellent in colorless transparency and surface smoothness and low in hygroscopicity.

**SOLUTION:** An injection molding machine equipped with a screw or cylinder having a surface with a surface roughness (Ra) of 0.2  $\mu\text{m}$  or less and a peel strength of 20 kg/cm<sup>2</sup> or less is used to perform the injection molding of an alicyclic polymer such as a hydrogenated norbornene ring opening polymer under a condition wherein cylinder temp. is 240-290° C, mold temp. is 90-135° C, nozzle temp. is 230-260° C and the number of rotations of a screw is 20-40 rpm to obtain an optical member excellent in colorless transparency and surface smoothness and low in hygroscopicity.

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CLAIMS

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[Claim(s)]

[Claim 1] The process of the optical member which carries out injection molding of the alicyclic polymer using the injection molding machine equipped with the screw and/or cylinder which have a front face with a peel strength of 20kg/cm<sup>2</sup> or less.

[Claim 2] The process of the optical member which carries out injection molding of the alicyclic polymer using the injection molding machine equipped with the screw and/or cylinder which surface roughness (Ra) is 0.2 micrometers or less, and have a front face with a peel strength of 20kg/cm<sup>2</sup> or less.

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DETAILED DESCRIPTION

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## [Detailed Description of the Invention]

[0001]

[Field of the Invention] About the process of an optical member, in more detail, this invention is excellent in transparent and colorless nature (it does not yellow) and surface smooth nature, and relates to the optical member of low hygroscopicity, and the process for manufacturing suitably lenses (ftheta lens, the pickup lens for disks, lens for cameras, etc.) by the sex from Takao especially.

[0002]

[Description of the Prior Art] Since transparency is high, this polymer is formed in optical members, such as a lens and an optical disk, by approaches, such as injection molding, and the norbornene system addition polymer, and a norbornene system ring-opening-polymerization object and the alicyclic polymer like the hydrogenation object are used. however -- the lens obtained using the usual injection molding machine -- yellowing -- that what variety entertainments etc. might mix or was ruined is formed \*\*\*\* -- etc. -- it carried out. Generally, in order to reduce burning in injection molding, making an injection speed late and giving sufficient time amount for discharge is known, but if an injection speed is made late, productivity falls and it is not desirable. Moreover, using the metal mold which stood the knockout pin, the gas drainage pin, etc., or prepared the gas relief groove in the parting surface so that air and gas might be easy to be discharged is also known. However, also by the approach learned from these former, when long duration operation was carried out, the colored optical member and the low optical member of surface smooth nature might be produced.

[0003]

[Problem(s) to be Solved by the Invention] The purpose of this invention is to offer the process for excelling in transparent and colorless nature and surface smooth nature, and manufacturing the optical member of low hygroscopicity by the sex from Takao. In order to attain the above-mentioned purpose, as a result of inquiring wholeheartedly, using the injection molding machine equipped with the screw and/or cylinder which have the front face of low peel strength, by carrying out injection molding of the alicyclic polymer, this invention persons are excellent in transparent and colorless nature, find out that the optical member of low hygroscopicity can be manufactured suitably, and came to complete this invention based on these knowledge.

[0004]

[Means for Solving the Problem] In this way, according to this invention, the process of the optical member which carries out injection molding of the alicyclic polymer is offered using the injection molding machine equipped with the screw and/or cylinder which the process of the optical member which carries out injection molding of the alicyclic polymer, and surface roughness (Ra) are 0.2 micrometers or less, and have a front face with a peel strength of 20kg/cm<sup>2</sup> or less using the injection molding machine equipped with the screw and/or cylinder which have a front face with a peel strength of 20kg/cm<sup>2</sup> or less.

[0005]

[Embodiment of the Invention] The process of this invention is the approach of carrying out injection molding of the alicyclic polymer using the injection molding machine equipped with the screw and/or cylinder which have a front face with a peel strength of 20kg/cm<sup>2</sup> or less.

[0006] The injection molding machine used by this invention is equipped with the screw and/or cylinder in which peel strength has preferably 20kg/cm<sup>2</sup> or less of 15kg/cm<sup>2</sup> or less of front faces 10kg/cm<sup>2</sup> or less still more preferably. It excels in transparent and colorless nature and smooth nature, and the optical member of low hygroscopicity can be obtained, so that peel strength is low.

[0007] In this invention first peel strength on the front face of a screw or a cylinder to or a test piece with the same front face as a screw or a cylinder After carrying the pellet of an alicyclic polymer and leaving it for 60 minutes in 300-degree C gear oven, It cools to a room temperature, next an omnipotent \*\*\*\* compression tester (TCM500: product made from New Communication link Industry) is used. The condition for load cell 500kgf

for compression, and 1mm/of compression velocity It is the value measured and acquired by performing the trial which presses the indenter which consists of a stainless steel plate with a thickness of 0.5mm from the include angle of 25 degrees to the front face of a test piece, and removes a pellet.

[0008] In order to obtain the screw and/or cylinder which have the front face of such peel strength, the suitable ingredient which constitutes them is usually selected. As an ingredient, carbide, such as nitrides, such as TiN and TiCN, W<sub>2</sub>C, and TiC, Fe-B-Mo steel, Co-Cr-B steel, etc. are mentioned. Among these The cylinder and/or screw which use Co-Cr-B steel as a base ingredient, coat the base ingredient with TiN, TiCN, or W<sub>2</sub>C, and are obtained are suitable.,

[0009] 0.18 micrometers or less of the surface roughness of the screw and/or cylinder with which this injection molding machine is equipped (Ra) are 0.2 micrometers or less usually 0.15 micrometers or less still more preferably preferably. The high optical member of transparent and colorless nature and surface smooth nature can be obtained, so that surface roughness is small. In order to adjust to such surface roughness, the front face of a screw and/or a cylinder is performed for electrolytic polishing, buffing, etc. In this invention, although it is required for either a screw or a cylinder and both to have said front face, it is important that especially the front face of a cylinder is in said condition.

[0010] Injection molding machine used by this invention It has the screw and/or cylinder which have a front face like the above, and also is the usual thing.

[0011] The alicyclic polymer used for this invention is a polymer which has alicyclic structure in a principal chain and/or a side chain. The polymer which contains alicyclic structure in a principal chain from viewpoints, such as a mechanical strength and thermal resistance, is suitable. As alicyclic structure, although cycloalkane structure, cycloalkene structure, etc. are mentioned, viewpoints, such as a mechanical strength and thermal resistance, to cycloalkane structure is desirable. Moreover, as alicyclic structure, a monocycle, many rings, condensation many rings, cross-linking \*\*\*\*, these combination many rings, etc. are mentioned. 4-30 pieces, although there is no limit with the exceptional carbon atomic number which constitutes alicyclic structure, when it is 5-15 range more preferably, a mechanical strength, thermal resistance, and many properties of a moldability balance highly, and it is usually preferably suitable [ properties ] for it 5-20 pieces.

[0012] Although the rate of a repeat unit of having the alicyclic structure in an alicyclic polymer is suitably chosen according to the purpose of use, preferably, it is 70 % of the weight or more more preferably, and the upper limit is 30 % of the weight or more usually 100 % of the weight 50% of the weight or more. If there are too few rates of a repeat unit of having the alicyclic structure in an alicyclic polymer, it is not inferior [ thermal resistance ], and desirable. There is no limitation with the exceptional remainders other than the repeat unit which has the alicyclic structure in an alicyclic polymer, and it is suitably chosen according to the purpose of use. That is, the copolymer of not only the homopolymer or copolymer of the monomer which has alicyclic structure but an it and the non-alicyclic monomer which can be copolymerized can be used. Moreover, an alicyclic polymer may hydrogenate an unsaturated bond and may process making it saturation association etc.

[0013] As an example of an alicyclic polymer, a norbornene system polymer, the annular olefin system polymer of a monocycle, an annular conjugated diene system polymer, vinyl system cyclic-hydrocarbon polymers, these hydrogenation objects, etc. are mentioned, for example. Also in these, a norbornene system polymer and its hydrogenation object, an annular conjugated diene system polymer, its hydrogenation object, etc. are desirable, and a norbornene system polymer and its hydrogenation object are more desirable.

[0014] As a norbornene system polymer, what carried out the polymerization of the norbornene system monomer is mentioned by the approach which an exceptional limit does not have, for example, is indicated by JP,3-14882,A, JP,3-122137,A, etc. Specifically, the ring-opening-polymerization object of a norbornene system monomer and its hydrogenation object, the addition mold polymer of a norbornene system monomer, the addition mold polymer of a norbornene system monomer and a vinyl system monomer, etc. are mentioned. Also in these, when making thermal resistance and a dielectric constant balance highly, the ring-opening-polymerization object hydrogenation object of a norbornene system monomer, the addition mold polymer of a norbornene system monomer, and the addition mold polymer of a norbornene system monomer and the vinyl system monomer which can be copolymerized are desirable, and especially the ring-opening-polymerization object hydrogenation object of a norbornene system monomer is desirable.

[0015] A norbornene system monomer Each above-mentioned official report and JP,2-227424,A, It is the well-known monomer currently indicated by JP,2-276842,A etc. For example, a bicyclo [2.2.1]-hept-2-en (trivial name: norbornene), A 5-methyl-bicyclo [2.2.1]-hept-2-en, 5, and 5-dimethyl-bicyclo [2.2.1]-hept-2-en, A 5-ethyl-bicyclo [2.2.1]-hept-2-en, a 5-butyl-bicyclo [2.2.1]-hept-2-en, A 5-hexyl-bicyclo [2.2.1]-hept-2-en, a 5-octyl-bicyclo [2.2.1]-hept-2-en, A 5-octadecyl-bicyclo [2.2.1]-hept-2-en, a 5-ethylidene-bicyclo [2.2.1]-hept-2-en, 5-methylidene-bicyclo [2.2.1]-hept-2-en, 5-vinyl-bicyclo [2.2.1]-hept-2-en, [0016] A 5-propenyl-bicyclo [2.2.1]-hept-2-en, 5 - Methoxy-carbinyl-bicyclo [2.2.1]-hept-2-en, A 5-cyano-bicyclo [2.2.1]-hept-2-en, 5-

methyl - 5-methoxycarbonyl-bicyclo [2.2.1]-hept-2-en, 5-ethoxycarbonyl-bicyclo [2.2.1]-hept-2-en and bicyclo [2.2.1]-hept-5-enyl-2-methylpropionate, bicyclo [2.2.1]-hept-5-enyl-2-methyl OKUTANEITO, [0017] The bicyclo [2.2.1]-hept-2-en -5, 6-dicarboxylic acid anhydride, A 5-hydroxymethyl bicyclo [2.2.1]-hept-2-en, 5, a 6-JI (hydroxymethyl)-bicyclo [2.2.1]-hept-2-en, A 5-hydroxy-i-propyl bicyclo [2.2.1]-hept-2-en, 5, a 6-dicarboxy-bicyclo [2.2.1]-hept-2-en, The bicyclo [2.2.1]-hept-2-en -5, 6-dicarboxylic acid imide, A 5-cyclopentyl-bicyclo [2.2.1]-hept-2-en, A 5-cyclohexyl-bicyclo [2.2.1]-hept-2-en, 5-cyclohexenyl-bicyclo [2.2.1]-hept-2-en, 5-phenyl-bicyclo [2.2.1]-hept-2-en, [0018] Tricyclo [4. 3.0.12, the 5] deca -3, 7-diene (trivial name: dicyclopentadiene), tricyclo [— 4. — 3.0.12, a 5] deca-3-en, and tricyclo [— 4. — 4.0.12, 5] undeca -3, 7-diene, or tricyclo [— 4. — 4.0.12, 5] undeca -3, and 8-diene — Tricyclo [4. 4.0.12, a 5] undeca-3-en, tetracyclo [7.4.0.110, 13.02, 7]-trideca - 2, 4, 6-11-tetraene (alias name: 1, 4-methano - 1, 4, 4a, 9a-tetrahydro fluorene), tetracyclo [8.4.0.111, 14.03, and 8] — the - tetra-deca -3, 5 and 7, and 12-11-tetraene (alias name: 1, 4-methano - 1, 4a [ 4 ], 5, 10, and 10a-hexahydro anthracene), [0019] Tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en (trivial name: tetracyclo dodecen), 8-methyl-tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en, 8-ethyl-tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en, 8-methylidyne-tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en, 8-ethylidene-tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en, 8-vinyl-tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en, 8-propenyl-tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en, 8-methoxycarbonyl-tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en, 8-methyl-8-methoxycarbonyl-tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en, 8-hydroxymethyl-tetracyclo [— 4. — 4.0.12, 5.17, 10]-dodeca-3-en, and 8-carboxy-tetracyclo [— 4. — 4.0.12, 5.17, and a 10]-dodeca-3-en, [0020] 8-cyclopentyl-tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en, 8-cyclohexyl-tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en, 8-cyclohexenyl-tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en, 8-phenyl-tetracyclo [4. 4.0.12, 5.17, 10]-dodeca-3-en, PENTA cyclo [— 6. — 5. — 1.13, 6.02, 7.09, 13] pen TADEKA -3, 10-diene, and PENTA cyclo [— 7. — 4.0. — 13, 6.110, 13.02, 7]-pen TADEKA -4, 11-diene, etc. are mentioned.

[0021] These norbornene system monomers are independent, respectively, or can be used combining two or more sorts. A norbornene system polymer may be a copolymer of a norbornene system monomer, and it and other monomers which can be copolymerized. Although the rate of the amount of norbornene system monomer association in a norbornene system polymer is suitably chosen according to the purpose of use, 30% of the weight or more, a dielectric constant, thermal resistance, and the property of elongation balance highly, and what is 70 % of the weight or more more preferably is usually preferably suitable for it 50% of the weight or more.

[0022] As a norbornene system monomer and a vinyl system monomer which can be copolymerized For example, ethylene, a propylene, 1-butene, 1-pentene, 1-hexene, A 3-methyl-1-butene, 3-methyl-1-pentene, 3-ethyl-1-pentene, A 4-methyl-1-pentene, 4-methyl-1-hexene, 4, and 4-dimethyl-1-hexene, 4 and 4-dimethyl-1-pentene, a 4-ethyl-1-hexene, a 3-ethyl-1-hexene, 1-octene, 1-decene, 1-dodecen, 1-tetra-decene, 1-hexa decene, The ethylene or the alpha olefins of carbon numbers 2-20, such as 1-octadecene and 1-ray KOSEN; Cyclobutene, Cyclopentene, a cyclohexene, 3, 4-dimethyl cyclopentene, 3-methyl cyclohexene, a 2-(2-methylbutyl)-1-cyclohexene, Cycloolefins, such as a cyclooctane, a [ 3 ], 5 and 6, 7a-tetrahydro-4, and 7-methano-1H-indene; 1, 4-hexadiene, Nonconjugated diene [ , such as 4-methyl -1, 4-hexadiene, 5-methyl -1, 4-hexadiene, 1 and 7-OKUTA diene, ]; etc. is mentioned. These vinyl system monomers are independent, respectively, or can be used combining two or more sorts.

[0023] There is no limit with the exceptional polymerization method and hydrogenation approach of a norbornene system monomer or a norbornene system monomer, and the vinyl system monomer that can be copolymerized, and it can be performed according to a well-known approach.

[0024] As an annular olefin system polymer of a monocycle, the addition (\*\*) polymer of the annular olefin system monomer of monocycles, such as a cyclohexene currently indicated by JP,64-66216,A, a cyclo heptene, and cyclooctane, can be mentioned, for example.

[0025] As an annular conjugated diene system polymer, it is 1 and 2-, or 1 and 4 about annular conjugated diene system monomers currently indicated by JP,6-136057,A and JP,7-258318,A, such as a cyclopentadiene and cyclohexadiene, for example. - The polymer (\*\*) which carried out addition polymerization, its hydrogenation object, etc. can be mentioned.

[0026] The object which hydrogenated the ring part of the polymer, of vinyl aromatic series system monomers, such as styrene and alpha methyl styrene, currently indicated by a polymer and its hydrogenation object, JP,63-43910,A, JP,64-1706,A, etc. of vinyl system cyclic-hydrocarbon system monomers, such as a vinyl cyclohexene. currently indicated by JP,51-59989,A and a vinyl cyclohexane, as a vinyl system cyclic-hydrocarbon system polymer, for example can be mentioned.

[0027] Moreover, an alicyclic polymer may have polar groups, such as hydroxyl and a carboxyl group. The alicyclic polymer which has a polar group is obtained by copolymerizing as a comonomer the monomer containing for example, introducing into said alicyclic polymer the compound which has a polar group by the reaction of degeneration or (1) (2) polar group. As a polar group, hydroxyl, a carboxyl group, an oxy-radical, an epoxy group,

a glycidyl group, an oxy-carbonyl group, carbonyloxy group, a carbonyl group, amino group, etc. are mentioned.

[0028] The aforementioned alicyclic polymer is independent, respectively, or can be used combining two or more sorts.

[0029] Especially an alicyclic polymer is not restricted by the molecular weight. the weight average molecular weight (Mw) of the polystyrene conversion measured with the gel permeation chromatography (GPC) with which the molecular weight of an alicyclic polymer uses chloroform (or a cyclohexane or toluene) as a solvent -- it is -- usually -- 1,000-1,000,000 -- desirable -- 5,000-500,000 -- it is the range of 10,000-250,000 more preferably. When the weight average molecular weight (Mw) of an alicyclic polymer is in this range, thermal resistance, an adhesive property, the smooth nature of a film, etc. balance highly, and are suitable.

[0030] the ratio (Mw/Mn) of the weight average molecular weight (Mw) and number average molecular weight (Mn) which are measured by GPC to which the molecular weight distribution of an alicyclic polymer use toluene as a solvent -- it is -- usually -- it is three or less more preferably four or less five or less. Although the range and measuring method of the above-mentioned weight average molecular weight (Mw) and a molecular weight distribution (Mw/Mn) suit suitable for a norbornene system polymer, they are not limited to it. Moreover, when it is the alicyclic polymer which can measure neither weight average molecular weight nor molecular weight distribution by the above-mentioned approach, what has the melt viscosity and polymerization degree of extent which can form a resin layer by the usual melting processing method can be used.

[0031] Although the glass transition temperature of an alicyclic polymer should just be suitably chosen according to the purpose of use, it is usually 125 degrees C or more 100 degrees C or more 70 degrees C or more preferably 50 degrees C or more.

[0032] In this invention, a compounding agent can be added to an alicyclic polymer if needed. As a compounding agent, if used for the general resin industrial world, there will be no exceptional limit, for example, a curing agent, a hardening accelerator, a hardening assistant, a filler, a heat-resistant stabilizer, a weathering stabilizer, a flame retarder, a leveling agent, an antistatic agent, a slipping agent, an anti blocking agent, an antifogger, lubricant, a color, a pigment, natural oil, synthetic oil, a wax, an antioxidant an ultraviolet ray absorbent, light stabilizer-proof, a coloring agent etc. mentioned, and the blending ratio of coal be suitably chosen in the range which do spoil the purpose of this invention

[0033] Moreover, in this invention, a gum polymer or thermoplastics can be blended with an alicyclic polymer if needed. As a gum polymer, for example Natural rubber, polybutadiene rubber, polyisoprene rubber, Acrylonitrile butadiene copolymer rubber, styrene butadiene copolymer rubber, Diene system rubber, such as styrene isoprene copolymer rubber and styrene butadiene isoprene ternary polymerization object rubber; The ethylene and the alpha olefin copolymers of these diene system rubber, such as hydrogenation object; ethylene propylene rubber, Saturation polyolefine rubber, such as an alpha olefin copolymer of propylene -- and others; An ethylene propylene diene copolymer, An alpha olefin diene copolymer, an isobutylene isoprene copolymer, Alpha olefin diene system polymer rubber, such as an isobutylene diene copolymer; Polyurethane rubber, Silicone rubber, polyether system rubber, acrylic rubber, propylene oxide rubber, Special rubber, such as ethylene-acrylic rubber; Styrene styrene-butadiene-rubber block-copolymer rubber, aromatic series vinyl system thermoplastic-elastomer [ such as a styrene isoprene styrene block copolymer, ]; and hydrogenation object [ of aromatic series vinyl system thermoplastic elastomer ]; -- thermoplastic-elastomer-urethane; -- thermoplastic-elastomer-polyamide; -- Thermoplastic 1,2-polybutadiene; etc. is mentioned.

[0034] As thermoplastics, polyamide; ethylene-ethyl acrylate copolymers, such as polyester; nylon 6, such as polyolefine; polyethylene terephthalate, such as polyethylene (low density polyethylene, high density polyethylene, straight chain-like low density polyethylene, super-low density polyethylene, etc.), polypropylene, syndiotactic polypropylene, polybutene, and the poly pentene, and polybutylene terephthalate, and Nylon 66, an ethylene-vinylacetate copolymer, a polycarbonate, etc. are mentioned, for example. Polyethylene and polypropylene are [ among these ] suitable.

[0035] It is desirable to usually make preferably 200-340 degrees C of cylinder temperatures into about 240-290 degrees C, although especially the conditions of injection molding are not limited, to usually set preferably 80-150 degrees C of die temperatures as the temperature of about 90-135 degrees C, to usually make nozzle temperature into about 260-300 degrees C, and to carry out injection molding. an injection pressure -- usually -- 300 - 1900 kgf/cm<sup>2</sup> -- it is 500 - 1600 kgf/cm<sup>2</sup> preferably. It is an injection speed and a 10-100cm<sup>3</sup>/second of usual, and usually injects in 0.5 - 7 seconds as injection time amount. dwelling -- usually -- 50 - 2000 kgf/cm<sup>2</sup> -- it is 300 - 1900 kgf/cm<sup>2</sup> preferably, and usually maintains for 1 to 180 seconds by the dwelling. The rotational frequency of a screw is usually 20 - 70rpm preferably ten to 90 rpm.

[0036] Although especially the metal mold used for injection molding is not limited, in order to extract the gas which occurs at the time of injection molding, it is desirable to equip metal mold with a gas drainage slot. In this

Invention, when forming ftheta lens, it is desirable to prepare the hole for drainage. By extracting gas, the surface smooth nature of an injection-molding object becomes high, and transparent and colorless nature also becomes high.

[0037]

[Example] An example is shown and the process of this invention is explained concretely. The evaluation approach performed in this example is as follows.

(Peel strength) Up to [ after putting a resin pellet on a test piece with a screw or the same front face as the front face of a cylinder first and leaving it for 60 minutes in 300-degree C gear oven ] a room temperature It measured by performing the trial which cools, next presses the indenter which consists of a stainless steel plate with a thickness of 0.5mm from the include angle of 25 degrees to the front face of a test piece using an omnipotent \*\*\*\* compression tester (TCM500: product made from New Communication link Industry) the condition for load cell 500kgf for compression, and 1mm/of compression velocity, and removes a pellet. (Yellowing whenever) yellowing sample the mold goods at the time of 6-hour continuous molding for every hour, and according to a color difference meter -- whenever -- (YI) measurement -- carrying out -- the average -- having taken .

(Burning foreign matter) The generating rate (%) in the inside of the continuation shot of 6 hours estimated the case where a resin burning object 50 micrometers or more was checked by visual evaluation.

[0038] example 1 tricyclo [--- 4. --- 3.0.12, the 5] deca -3, 7-diene, and 8-ethyl tetracyclo [--- 4. --- 4.0.12, 5.17, and a ring-opening-polymerization object with a 10]-dodeca-3-en were hydrogenated, and weight average molecular weight acquired [ 36,000 and Mw/Mn / 2.1 and glass transition temperature ] the hydrogenation ring-opening-polymerization object which is 136 degrees C. Peel strength taught the pellet of said hydrogenation ring-opening-polymerization object to the injection molding machine equipped with the cylinder which has 5kg/cm2 and the front face of 0.12 micrometers of averages of roughness height, and the screw on which peel strength has 6kg/cm2 and the front face of 0.11 micrometers of averages of roughness height, carried out melting kneading, injected to the metal mold for ftheta lenses, and fabricated ftheta lens. In addition, about 270 degrees C and a die temperature were set as about 120 degrees C, about 20 rpm and a cylinder temperature set nozzle temperature as about 265 degrees C, and the rotational frequency of a screw injected them in injection-pressure about 1500 kgf/cm2, and the about 20cm3/second (injection time amount = about 1 second) of injection speeds, and carried out dwelling about 750 to 1750 kgf/cm2 (30-second maintenance). Moreover, the cylinder and the screw are formed with Co-Cr-B steel, and coating of the TiN is carried out to the front face. yellowing in ftheta lens which carried out continuation shot shaping for 6 hours -- whenever -- (--- the evaluation result of YI) and burning object mixing was shown in Table 1. Obtained ftheta lens did not almost have a foreign matter, that of surface smooth nature was good, and was low hygroscopicity.

[0039] The cylinder in which example 2 peel strength has 5kg/cm2 and the front face of 0.10 micrometers of averages of roughness height, and the injection molding machine with which peel strength was equipped with the screw which has 9kg/cm2 and the front face of 0.14 micrometers of averages of roughness height were used, and also ftheta lens was fabricated like the example 1. The evaluation result was shown in Table 1. The cylinder is formed with Co-Cr-B steel, and coating of W2C is carried out to the front face. The screw is formed with Fe-B-Mo steel. The evaluation result was shown in Table 1. Obtained ftheta lens did not almost have a foreign matter, that of surface smooth nature was good, and was low hygroscopicity.

[0040] The cylinder in which example 3 peel strength has 9kg/cm2 and the front face of 0.13 micrometers of averages of roughness height, and the injection molding machine with which peel strength was equipped with the screw which has 6kg/cm2 and the front face of 0.11 micrometers of averages of roughness height were used, and also ftheta lens was fabricated like the example 1. The evaluation result was shown in Table 1. A cylinder is formed with Fe-B-Mo steel, and coating of the TiC is carried out to the front face. The screw is formed with Co-Cr-B steel, and coating of the TiCN is carried out to the front face. The evaluation result was shown in Table 1. Obtained ftheta lens did not almost have a foreign matter, that of surface smooth nature was good, and was low hygroscopicity.

[0041] The cylinder in which example of comparison 1 peel strength has 30kg/cm2 and the front face of 0.3 micrometers of averages of roughness height, and the injection molding machine with which peel strength was equipped with the screw which has 26kg/cm2 and 0.4 micrometer front face of averages of roughness height were used, and also ftheta lens was fabricated like the example 1. The evaluation result was shown in Table 1. The cylinder and the screw are formed with nitriding steel, and chrome plating is carried out to the front face. The evaluation result was shown in Table 1. A foreign matter may be occasionally contained in obtained ftheta lens, and what has low surface smooth nature was contained in such a lens.

[0042]

[Table 1]



表 1

	実施例 1	実施例 2	実施例 3	比較例 1
シリンジ				
剥離強度 [ $\text{kg} / \text{cm}^2$ ]	5	5	9	30
平均粗さ [ $\mu\text{m}$ ]	0.12	0.10	0.13	0.3
スクリー				
剥離強度 [ $\text{kg} / \text{cm}^2$ ]	6	9	6	26
平均粗さ [ $\mu\text{m}$ ]	0.11	0.14	0.11	0.4
黄変度 (YI) [%]	0.5	0.6	0.7	0.9
焼け物発生 [%]	0.1	0.1	0.1	1.5

[0043]

[Effect of the Invention] According to the process of this invention, it excels in transparent and colorless nature and surface smooth nature, and the optical member (theta lens, the pickup lens for disks, lens for cameras, etc.) of low hygroscopicity, for example, lenses, prism, disks (CD, CD-R, etc.), a film or plates (an optical diffusion film, light guide films, or those plates), a checking cel, etc. can be easily obtained by the process of this invention. Especially the process of this invention is suitable for a lens.

[Translation done.]